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The CHINCH BUG

AND HOW TO FIGHT IT

THE CHINCH BUG, an insect only about one-sixth of an inch long when full grown, is one of the most destructive of all the native pests which attack grain and grass crops in the United States. It is of importance in the eastern and southeastern sections of the country and in parts of eastern Canada, and has been somewhat harmful on the Pacific slope; but it has reached its greatest abundance and received the most serious attention as a pest in the valleys of the Mississippi, Ohio, and Missouri Rivers.

This insect has some natural enemies, but they can not be depended upon for protection to crops. It is to be fought chiefly by (1) burning the bugs in their winter quarters, (2) growing crops on which they do not feed, and (3) killing them at the proper place by the use of barriers, sprays, and dusts. Spraying and dusting, to be effective against the chinch bug, are expensive, and are recommended only for cases of emergency. Barriers of various forms are the standard means of control.

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THE CHINCH BUG[1] AND HOW TO FIGHT IT

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OCCURRENCE AND IMPORTANCE OF THE CHINCH BUG

THE CHINCH BUG is one of the most destructive of all the native insects attacking grain and grass crops in this country. It is of some importance in the southeastern and eastern sections of the country, but has reached its greatest abundance in the valleys of the Mississippi, Ohio, and Missouri Rivers. It has been reported as having occurred in destructive numbers on the Pacific slope, but the injury there has been slight compared with that in the great Corn Belt of the Middle West. The chinch bug is a pest of considerable importance in parts of eastern Canada, its damage there being largely confined to timothy and other grasses, and small grains.

A knowledge of the best methods of controlling this insect has been of importance to grain growers since its first general outbreak, which occurred about 1785. The great numbers in which the insect occurs, the very wide distribution of the plants upon which it feeds, and its high rate of reproduction make it an extremely difficult pest to fight. The fact that it is a sucking insect and can not be killed by applying poisons to the plants on which it feeds adds to the difficulty of its control. During the past 150 years there have been numerous outbreaks of this insect; in some instances covering only parts of one or two States, but extending in others over a much wider area.

SEASONAL HISTORY

There are two generations of the chinch bug each season throughout the entire range over which it occurs in this country. Long-winged and short-winged forms are generally found, the latter being more abundant in the East and North. The wings of this form are not developed sufficiently to permit flight. The chinch bug overwinters full grown and hidden away in some shelter which affords protection from the weather.

[1] *Blissus leucopterus* Say; order Hemiptera, family Lygaeidae.

The greater number of these bugs seek shelter in the bases of the clump-forming native grasses, where such grasses are abundant. These grasses are known locally as prairie grass, broom grass, bluestem, bunch grass, swale grass, beard grass, and by several other names. These varieties of grass probably served the chinch bug as food before the land came under cultivation; and although it has practically abandoned them so far as feeding is concerned, the bug still seeks their shelter during the winter. Where these grasses do not occur in abundance, as is the case in many of the States where the chinch bug is destructive, it frequents the south and west sides of woodlands, the south slopes of roadsides, hedges, ditch banks, and similar places. The bugs seem to prefer a mixture of grasses and leaves (fig. 1) rather than a heavy cover of weeds or leaves alone. Chinch bugs may also be found under the woolly leaves of mullein plants, or any large-leafed plants growing in sheltered spots on the edges of fields or woodlands.

FIG. 1.—A mixture of grass and leaves which seems to be especially preferred by chinch bugs for winter quarters

Infrequently, considerable numbers of bugs occur under the bark of dead trees and fence posts, under boards and logs, or in shocks of corn. In the eastern part of the United States, where the short-winged form of the chinch bug is abundant, large numbers of the bugs may be found in timothy, but in the Middle West and in the South they are not so likely to seek shelter in this grass. Hibernating chinch bugs have been found under the loose boards of houses, loose shingles of roofs, in sheds and outbuildings, and various other shelters, but the percentage of bugs passing the winter in such places is relatively low. A few bugs go through the winter in standing stalks of corn in such States as Missouri, Iowa, Illinois, and Indiana, where most of the corn is husked in the field and the stalks are allowed to stand during the winter. Examination of large numbers of standing cornstalks in infested localities in Illinois has shown an average of a little less than one bug to two hills of corn.

To find the places in which bugs are hibernating one should make a careful examination of the sheltered spots having the favored types of cover previously described, and where the sun shines during the afternoons of September and October; it is during these afternoons that most of the bugs seek out their winter quarters. Most of the flights of bugs to winter quarters take place from the last week in September to the first week in November. The time of flight depends on the weather of the season, and always occurs while the sun is shining and on days when the temperature where it shines is at least 70° F. The bugs do not fly on cloudy days, even when the temperature is high.

Once in their winter quarters they become sluggish, and while the temperature remains below freezing they are inactive. During warm periods in the winter the bugs may move about to some extent, but this occurs only at times of high temperature. Usually no feeding is done from the time the bugs seek their winter quarters in the fall until they leave them in the spring, although mating may take place before the spring flight.

The general spring flights occur from February or March to the middle of May, on sunny days when for several hours the temperature is at least 70° F., usually only after one or two such days. Nearly all chinch bugs in any one locality leave their winter shelter during two or three such days and usually settle in fields of small grain. The greater part of the bugs locate in wheat where that is the predominating small-grain crop. They may often be found more abundant in rye or barley than in wheat where these grains are growing. In certain years, when oats have been planted early and cool weather has delayed the flight of the bugs until the oats have made a good growth in the field, the bugs may settle in this crop rather than in wheat. There is another period of flight, from two weeks to a month after the small grain is harvested. The purpose of this migration is to seek favorable feeding grounds and a place for depositing the eggs for the second generation of bugs. It is during this flight that the bugs become generally distributed over the corn and sorghum fields. A summary of the seasonal history of this insect is graphically presented in Figure 2.

LIFE HISTORY

Once in the fields of small grain, the insects begin feeding and laying their eggs. The eggs are deposited behind the lower blades of the grain plants or in the ground around the plants, and in dry years when the ground is cracked they may be laid on the roots.

Each female chinch bug lays from 100 to 300 eggs, the average being about 150. These eggs are not all laid on the same day, and from three to four weeks are required for a female to lay her full quota. The eggs hatch in from 7 to 45 days, depending mainly upon the temperature. A very young bug is small, of a bright red color, with a transverse band of white. In the course of its growth its skin is shed five times and each change gives it a darker-colored coat until, in the last stage before it acquires wings, it becomes grayish black with conspicuous white markings on the back. In all of these five stages the insect is wingless and has to depend entirely upon its legs for locomotion. In the sixth or adult stage the insect

is about one-sixth of an inch long, and is black with white markings. The long-winged form has a well-developed pair of wings, and is capable of flying considerable distances, probably as far as 10 miles with a favorable wind to help it along. It was previously supposed that the winged bugs were not generally abundant in the vicinity of the Atlantic coast, but during the last five years large numbers of the winged form have been found feeding on some of the clump-forming grasses growing along the sandy beaches of the New England coast.

MIGRATIONS

There are three distinct migrations of the chinch bugs during the year, the first occurring in spring, when they go from their winter quarters to the fields, where they feed and deposit their eggs; the second in the summer, when they move out of small-grain fields to corn and other food plants. The diffusion of the bugs throughout the cornfields when they mature later in the summer is not here considered a distinct and definite migration. The third migration occurs in the fall, when the chinch bugs fly to their winter quarters.

PLANTS ATTACKED

So far as known, the chinch bug feeds only on plants belonging to the grass family. This includes all of our small grains, corn, broomcorn, sorghum, millet, and the wild and cultivated grasses. Of the small grains, barley seems to be preferred above all others, as repeated instances have come under observation where a number of kinds of small grains, all in practically the same stage of development, were available to the bugs in the spring, and under these conditions barley has been by far the most heavily infested. Spring wheat, winter wheat, rye, and oats, seem to be attacked in about the order named, but where any one of these grains predominates the chinch bugs readily feed upon it. During April, May, and June probably 90 per cent of the bugs are found in the fields of small grain. Where the acreage of small grains is relatively low, the bugs may be found to some extent on such grasses as timothy, June grass, and several other wild grasses which appear during these months. Occasionally a few bugs occur on blue grass, but apparently this grass is not succulent enough to be attractive.

As the chinch bug feeds only by sucking, it is necessary for it to have a food plant with a considerable flow of sap, the stem of which can be readily pierced by the insect's beak. Throughout the corn-growing sections the second brood of chinch bugs depends mainly upon corn for food. (Fig. 3.) Chinch bugs also feed readily on broomcorn, millet, sorghum, and Sudan grass. Some of the bugs of the second generation get their food from the wild grasses growing in fields during July, August, and September. Barnyard grass, tickle grass, crab grass, and foxtail are the main species fed upon. In the East, in areas where the short-winged form is abundant, the second brood depends mainly upon timothy as a source of food. When other foods fail, the bugs of the second brood may feed to a very slight extent on blue grass, but it is doubtful if any large percentage of them are able to complete their growth when depending on this grass alone for food.

PLANTS NOT INJURED

It is fortunate that the chinch bug does not feed on any member of the great family of soil-building crops known as legumes. Clover, alfalfa, vetch, soy beans, cowpeas, sweet clover, peanuts, stalk peas, velvet beans, all are immune from chinch-bug injury. Other common crops not belonging to the grass family which may safely be grown during periods of chinch-bug abundance with the assurance that they will not be damaged are sunflowers, rape, stock beets, buckwheat, pumpkins, squashes, and all of the so-called truck or garden crops with the exception of sweet corn.

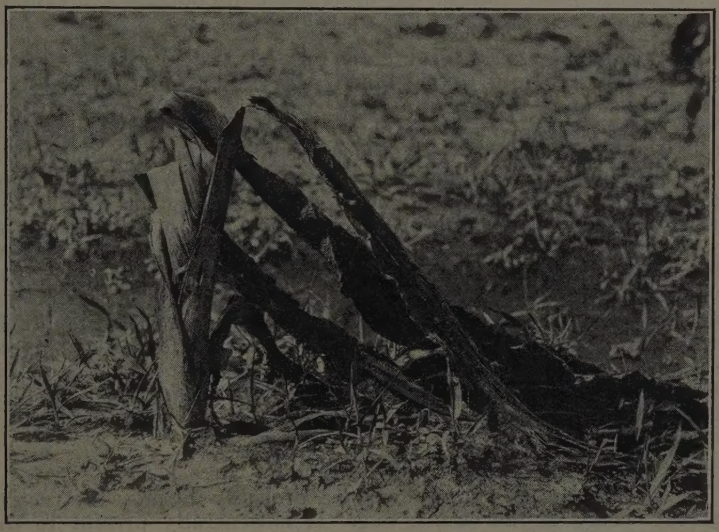


FIG. 3.—A typical corn plant killed by chinch bugs

CONDITIONS AFFECTING THE ABUNDANCE OF CHINCH BUGS

Chinch bugs occur over practically all of the United States with the exception of the arid and semiarid regions adjacent to the Rocky Mountains, and are present every year in varying numbers. Three general factors affect the abundance of chinch bugs—climatic conditions, systems of farming, and the presence of natural enemies.

CLIMATIC CONDITIONS

The weather is the chief factor governing the increase of the bugs to a point where they become seriously destructive to crops. The chinch bug is most susceptible to weather conditions during the hatching of the first and second broods of bugs. These periods extend from April to about the middle of June, and from about the middle of July to the middle of September. Frequent heavy, driving rains during these periods serve to beat the young bugs into the ground, from which they are unable to escape. Such storms cover the eggs with mud and prevent their hatching, and prevent

females from laying their full number of eggs. Frequent rains, or periods of warm, damp weather, make a condition very unfavorable to the chinch bug, and favorable to the development of a most destructive natural enemy, the white-fungus disease. In years when such weather occurs during either of the hatching periods of the bugs there is such high mortality among them that they become of little importance as farm pests for several succeeding seasons.

A very open wet winter is not so favorable to the chinch bug as a cold one with heavy snow. In the average season in the Middle West less than 10 per cent of the bugs die during hibernation. Sudden changes of temperature sometimes kill many.

SYSTEMS OF FARMING

The principal agricultural crops in the United States include several which are hosts to the chinch bug, so that under the ordinary existing systems of farming it always has an abundant supply of food. Farm practices can be modified, however, so as greatly to reduce this food supply during the years when the chinch bugs abound. For about five months of the year the chinch bug is not feeding, and must have sufficient shelter to afford it protection during the winter. In the greater part of the area infested, particularly in the eastern and western sections, there is enough broken, rough land, to offer favorable hibernating places. In some parts of the Mississippi Valley winter quarters are not so abundant, but probably no section is ever heavily infested with the chinch bugs where sufficient favorable shelter is not available. One of the best farm practices to be adopted as a means of combating these insects is to clean up all areas which offer conditions favorable to chinch-bug hibernation, such as field margins, roadsides, ditch banks, and the margins of woodlands.

NATURAL ENEMIES

The so-called white-fungus disease is probably the most destructive natural enemy of the chinch bug. It is generally present in the fields throughout the country, and its effectiveness is dependent on favorable weather conditions. Since it has been definitely proven that the spores of the fungus are present in all districts where the bugs are common, the artificial dissemination of the fungus is needless. Next in importance is a very tiny wasplike insect.[2] This little wasp lays an egg in the chinch-bug egg; the grub hatching from the wasp egg consumes the contents of the chinch-bug egg; and, when it has become a full-grown insect, the wasp emerges from that egg. This beneficial insect is so small that it is probably never seen by farmers in the field. When held in the palm of the hand, it appears merely as a little dark speck, and only microscopic examination reveals it as an insect; yet records show that it has parasitized from 30 to 50 per cent of the chinch-bug eggs in certain localities, although such a high percentage of parasitism is unusual. It is known to occur over most of the States of the Middle West, but has not been taken in the eastern or western parts of the United States. There are several others which are of some importance, but they do not act

[2] *Eumicrosoma beneficа* Gahan.

as a sufficient check on the chinch bug to prevent its rapid increase when conditions of weather and food are favorable for its development.

The bobwhite, redwing blackbird, catbird, brown thrasher, meadow lark, and a number of other birds are known to feed on the chinch bug, but it has not been shown that they consume it in sufficient numbers to give much aid in controlling this pest.

HOW TO FIGHT THE CHINCH BUG

All chinch-bug outbreaks in the past have begun during periods of normal or less than normal rainfall, and under other conditions suited to the rapid development of the insects. These outbreaks have persisted for varying periods, usually from two to three years, but sometimes much longer. By the end of the period the natural enemies of the chinch bug may have increased to a considerable extent, and adverse weather may have so reduced the number of the bugs that for several years they have been of little importance. One of the most persistent chinch-bug outbreaks on record originated in 1910, in Illinois, Missouri, and Kansas; in parts of these States there has been loss from chinch-bugs in every year since that time with the exception of 1915, when an extremely wet summer greatly reduced their numbers.

There is so much uncertainty about the duration of chinch-bug outbreaks that it is never safe for the grain grower to depend upon natural agencies to prevent losses from them. Three methods of control have been found of sufficient value to warrant recommendation: (1) Burning the bugs in their winter quarters, (2) avoiding their attacks by growing crops on which they do not feed, and (3) killing them by the use of barriers, sprays, and dusts at the time of the small-grain harvest. Numerous other methods of control have been tried at various times, and, though some bugs can be killed by most of them, the three just mentioned are the only means that have proved really practical and effective.

WINTER BURNING

In the States west of the Mississippi River where bunch grass is abundant enough to form the principal hibernating shelter, chinch bugs may be sufficiently reduced by thorough, organized burning in November and December to prevent serious crop losses from them the next summer. In the States east of the Mississippi River the bunch-forming grasses are not so common, and most of the bugs hibernate in other types of cover. It is doubtful whether chinch-bug outbreaks in this region can ever be cleaned up by winter burning; enough bugs, however, can be killed by this method to justify its constant practice where chinch bugs are abundant. Each female bug killed in the winter may mean a reduction of at least 100 bugs in the small grain in the following spring, and approximately 10,000 bugs of the following generation in the corn. It is therefore well worth while to burn, even though this destroys only 50 to 75 per cent of the chinch-bug shelters on any farm. Winter burning is of very little value anywhere if practiced only scatteringly by individual farmers. Community effort in this, as in so many

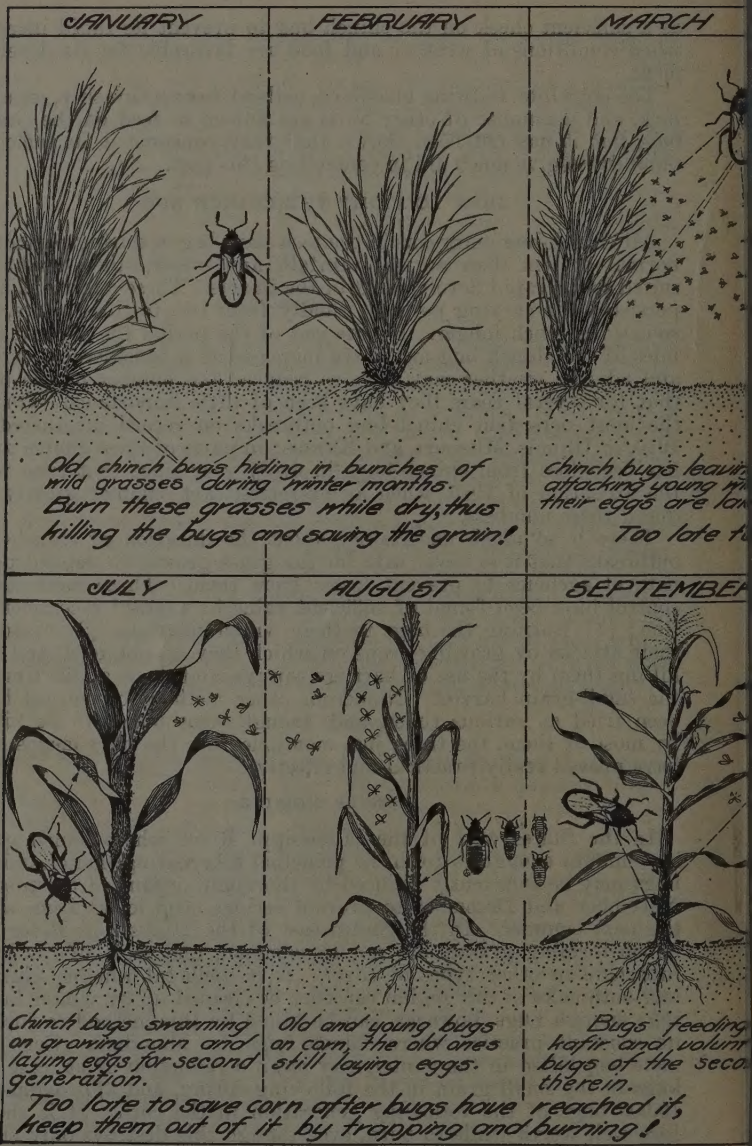
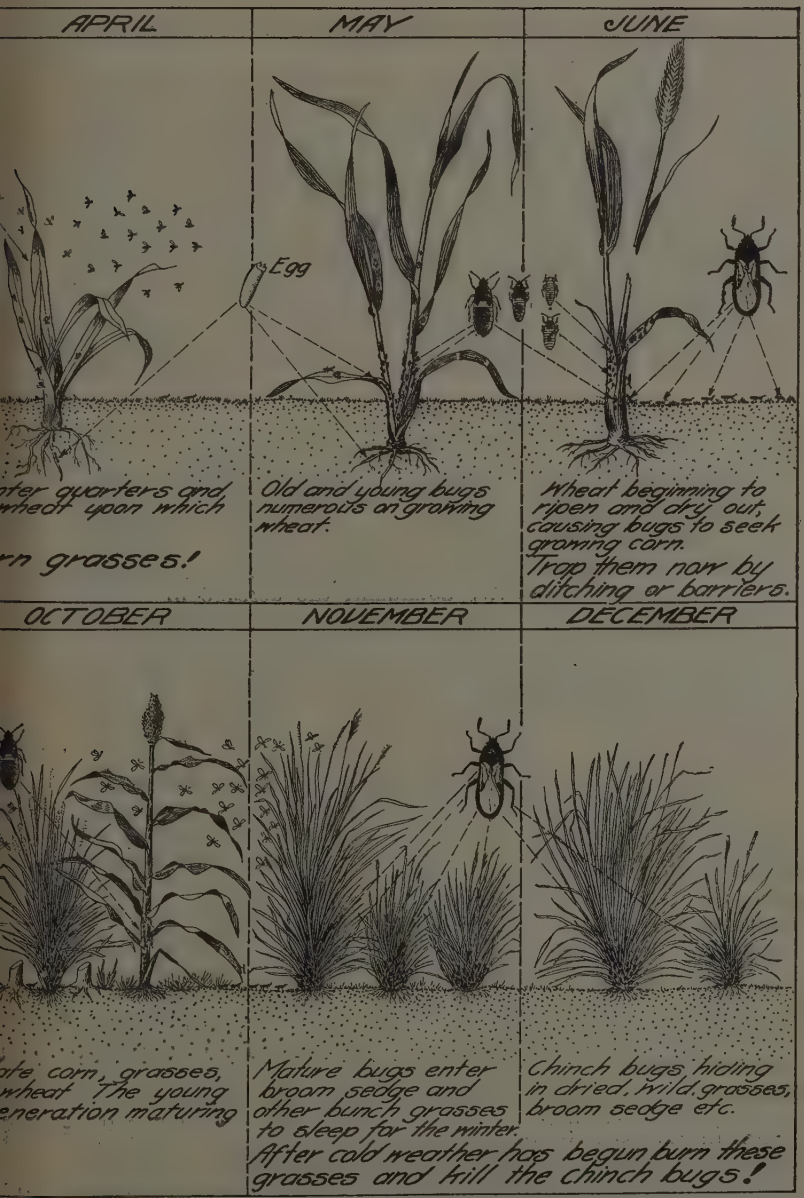

JANUARY
FEBRUARY
MARCH
Old chinch bugs hiding in bunches of wild grasses during winter months. Burn these grasses while dry, thus killing the bugs and saving the grain!
chinch bugs leavi
attacking young
their eggs are la
Too late t
JULY
AUGUST
SEPTEMBE
Chinch bugs swarming on growing corn and laying eggs for second generation.
Old and young bugs on corn, the old ones still laying eggs.
Bugs feeding
kafir and volun
bugs of the seco
therein.
Too late to save corn after bugs have reached it, keep them out of it by trapping and burning!

FIG. 2.—Chart showing seasonal history of the chinch bug in the Central States. During w
and in bunches of grass and the like. In February or March flight begins to young grain
wheat to growing corn, and at that time may be trapped in ditch barriers. Becoming
begun. When adult, from September 23 to the early part of November, they fly to hibern


APRIL
MAY
JUNE
Egg
ter quarters and,
heat upon which
rn grasses!
Old and young bugs numerous on growing wheat.
Wheat beginning to ripen and dry out, causing bugs to seek growing corn.
Trap them now by ditching or barriers.
OCTOBER
NOVEMBER
DECEMBER
ate corn, grasses, wheat The young eneration maturing
Mature bugs enter broom sedge and other bunch grasses to sleep for the winter.
After cold weather has begun burn these grasses and kill the Chinch bugs!
Chinch bugs hiding in dried, wild grasses, broom sedge etc.

from December to February, bugs are hibernating at edges of woodlands, under fallen leaves, nuing until about the middle of May. In June and July the bugs crawl in great numbers from about August 1, they fly to later corn, where eggs are laid and a second generation is uarters, where they remain until spring

other farm enterprises, is absolutely essential before even a fair degree of success can be obtained.

In attempting to burn bugs that are sheltered along the edges of woodlands, one should first consider the value of the woodland and the damage that may be done by fire. If there is a considerable amount of young growth and a heavy cover, so that the fire is likely to become hot enough to injure the trees, the woodland should not be burned. Careful examinations of woodlands have shown that nearly all of the chinch bugs about them are to be found within the first 25 feet from the south and west edges. Counts of the actual numbers of the bugs occurring in 10 different woodlots in Illinois show that more than 90 per cent of them were within 25 feet of the south edges of these lots. Under such conditions it would not be necessary to burn over an entire lot. In many cases more harm may be done by such burning than would occur from the bugs if left alive.

CROPPING

The individual farmer can very effectively avoid crop injury from the chinch bug by growing, where possible, crops on which the bug does not feed. This method not only insures against chinch-bug injury during the current year, but it is also a means of reducing the numbers of chinch bugs in the following season, as obviously they can not increase when their food supply is removed. Where chinch bugs become persistently abundant, the acreage of small grains, especially wheat, may be reduced as much as practicable and the land sown to resistant or immune crops, particularly legumes. In parts of the country where sunflowers, buckwheat, or stock beets can be profitably grown, these crops should be extensively planted during chinch-bug years. Legumes, such as red and sweet clovers, alfalfa, vetch, soy beans, and cowpeas, should not only be grown by themselves but they may well be planted in all small grains and corn where practical. Apparently there is nothing about these crops that is offensive to chinch bugs, since they will alight upon and crawl over them, and apparently are not repelled in any way. The growing of legumes in small grains and corn, however, produces a condition of shade and dampness around the lower parts of these plants which is unfavorable to chinch bugs and is avoided by them.

Experiments in growing corn with and without soy beans or cowpeas have shown that considerable protection is afforded the corn by these legumes. The corn grown with soy beans or cowpeas has outyielded the corn without these legumes by from 2 to 15 bushels per acre. The degree of benefit derived from this plan will depend on the numbers of chinch bugs present, the fertility of the soil, and the weather of the season. In extremely dry weather, with a heavy infestation of chinch bugs, the beneficial effect of the legumes may not be great; possibly the bugs will clean up all the corn in the field. Even under such conditions soy beans planted at the rate of three beans per hill of corn have yielded from 10 to 12 bushels per acre. Under nearly all conditions they may be expected to make sufficient plant growth to afford good pasturage for hogs, sheep, and cattle, and to give at least a partial crop on the land.

RESISTANT VARIETIES

Aside from the use of those plants which are immune from chinch-bug injury, it has been found that certain strains or varieties of some of the plants most severely injured by the chinch bugs are, to a certain extent, resistant to their attacks. Experimental work carried on over a period of six years in Illinois has shown that several varieties of corn are thus resistant. Black Hawk, Champion White Pearl, Golden Beauty, and Mohawk have been found the most promising of the several varieties included in these experiments. Under conditions of heavy chinch-bug infestation these varieties have made a fair yield, whereas other varieties grown in the same field were so badly damaged as to produce very little grain. None of these varieties are chinch-bug proof, however, and they appear to depend for their resistance upon certain vegetative characters.

Practically as many bugs occur on the resistant as on the nonresistant varieties of corn. Several varieties of corn have thus far been found uniformly resistant to chinch bugs. As very little experimental work along this line has been carried on outside of Illinois, it is impossible to state just what the performance of these varieties will be when grown under other conditions.

During the last five seasons the Kansas Experiment Station has been carrying on work of a similar nature in developing resistant strains of sorghum, achieving results comparable with those obtained with corn in Illinois. Several strains of resistant sorghums have been developed, but, as is the case with corn, the resistance has apparently been due to the vigor or structure of the plant and not to any character rendering it distasteful to chinch bugs.

BARRIERS

One of the oldest methods resorted to for controlling chinch bugs is the use at harvest time of barriers along which the young bugs can be killed as they crawl from small-grain stubble to the corn. At this time only a few bugs have reached the full-grown, or winged, stage. As the bugs are dependent for their food supply on a succulent plant, they are compelled to leave the small grain when the plants ripen and dry, or are cut, migrating mainly in the afternoons of sunny days. In cloudy weather there may be some movement of the bugs throughout the day. The march from the small-grain stubble to the corn affords an excellent opportunity for killing them and preventing damage by the second generation in the latter part of the summer. A number of kinds of barriers have been used, some of which are very effective.

CREOSOTE

During the last few years creosote has been used very largely as a barrier material. Experiments in several of the Central States have shown that this material is probably the best of any thus far tried for making and maintaining chinch-bug barriers.

The path for the creosote barriers is best made by throwing up a ridge of earth with a plow, disk cultivator, or small road grader, and

smoothing the surface so that it is free from clods or trash. A line of creosote should then be applied along the brow of the ridge, as shown in Figure 4, and post holes should be dug in the bottom of the furrow at distances of from 1 to 4 rods, depending on the number of bugs congregating along the barriers. The more numerous the bugs, the shorter should be the distances between the holes. The holes should be from 18 to 20 inches deep, flared at the top, and kept dusted with fine dust. The flare should extend up to the creosote line. Bugs attempting to leave the field and encountering the creosote line start moving along this line, and in an attempt to find a point where they can cross it tumble into one of the post holes. If the hole is kept dusty, the bugs can not crawl out. It is possible to catch very large numbers of chinch bugs by this method. As high as seven to eight bushels of bugs have been caught along half a mile

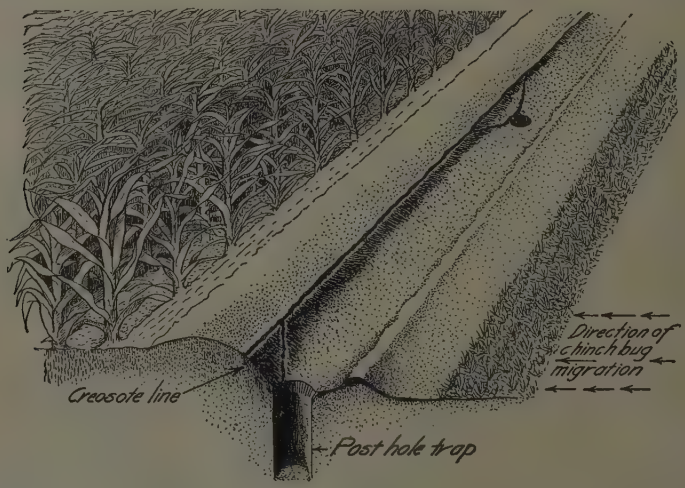


FIG. 4.—Sectional view of a creosote barrier for the control of chinch bugs. Note the line of creosote on the ridge, and the post holes in the bottom of the furrow

of barrier in a week. In this instance the measurements were carefully made, and approximately the same number of bugs were caught in the same field the next week. Counts of single quarts of chinch bugs have shown that there are between eight and eight and a half millions of them in a bushel, so that at least 60,000,000 chinch bugs were caught along this line in one week.

Creosote sinks into the ground immediately on being poured on it, and leaves along the surface a brownish line with a strong odor. There seems to be no physical reason why bugs can not cross this line, but probably on the average not more than one-tenth of 1 per cent of the bugs actually do so. A narrow line, one-half inch wide, is just as effective as one that is 2 or 3 inches wide. Only small quantities of creosote, therefore, need to be applied at one time.

A very convenient method of applying creosote is to punch a hole in the side of a galvanized pail or bucket with a 6- or 8-penny nail, about 1 inch from the bottom and under the point where the bail is attached, and allow the creosote to run from this hole, directing the stream so that with each application it will strike the same path on the ridge of earth. It is necessary to apply the creosote once a day for the first week, and after this, if care has been taken to follow the same path, it usually is necessary to apply it only every two or three days. Light rains have the effect of freshening the creosote; since the material is of an oily nature it comes to the surface when the ground is wet. One barrel, or 50 gallons, of creosote will, when properly applied, maintain a half mile of barrier for about three weeks, which ordinarily is sufficient for a season.

COAL OR GAS TAR

A very well-known type of barrier is made by pouring a narrow line of tar on a path made by smoothing the soil along the margin of the field to be protected, making the soil as firm and compact as possible. Chinch bugs are repelled by the odor of the tar, and while the tar is fresh it also acts as a physical barrier, making it impossible for the bugs to force their way over the sticky surface. Where the proper grade of tar can be obtained at a reasonable price it makes a very effective barrier. The best tars for this purpose are those from which the creosote and cresylic acids have not been distilled. Tars from which these materials have been taken have little value for chinch-bug barriers. In order to maintain this type of barrier with the greatest efficiency it is necessary to have a line of post holes in the ground on the inside, or grain-stubble side, of the tar line.

DUSTY FURROW

Of the different kinds of barriers the oldest and the one most widely used consists of a dusty furrow around the small-grain stubble. Such furrows are generally made by plowing a dead furrow, throwing the dirt both ways, and then dragging a log or trough of planks back and forth in this furrow until the sides have been worn down to a fine dust. Two furrows can be plowed parallel to each other and a double drag constructed having a raised connection to span the intervening bank. By means of this both furrows may be maintained with the same amount of labor for dragging as would be required for a single furrow. On certain types of soils, and during dry weather, dusty furrows make excellent barriers. While dry, these furrows, if frequently dragged, remain impassable to chinch bugs, and most of the bugs which fall into them are killed by the heat of the sun or by the fine particles of dust which penetrate their breathing tubes.

In some types of soil it is impossible to make a dust so fine that the chinch bugs can not crawl through it. In any case, dusty furrows are of no value during periods of rain. A heavy shower renders them passable to the bugs, and frequently allows sufficient numbers to cross to kill 1 or 2 acres of corn before a fresh dust can be

worked up. Although this barrier does not require any costly equipment or the expenditure of money for materials, constant labor is necessary in order to maintain it, and the expense is often greater than that of one of the other types of barriers requiring some special materials.

LIMESTONE AND KEROSENE

A fairly effective chinch-bug barrier can be made by throwing up a ridge of earth, as described for the creosote or coal-tar barrier, and on the top of this ridge scattering a narrow line of ground limestone such as is used for agricultural purposes, making this line about 3 inches wide and continuous along the top of the ridge. After the limestone is applied it should be thoroughly wet with kerosene. The kerosene may be applied in the same manner as the creosote, that is, from a hole in the side of a tin or galvanized bucket. Kerosene must be applied to such a barrier about twice a day, but it is very effective in stopping the bugs so long as the limestone is kept wet with it. Such a barrier is usually somewhat more expensive to

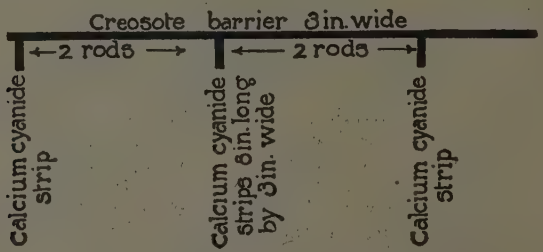


FIG. 5.—Method of laying calcium cyanide strips at right angles to a creosote or coal-tar barrier. (Flint)

maintain than one made with creosote or coal tar, because of the fact that the kerosene has to be applied at more frequent intervals. It has the advantage of being made from materials readily available on farms throughout the Corn Belt. With this barrier it is necessary to maintain the line of post holes in the same manner as with the creosote or coal-tar barriers.

CALCIUM CYANIDE

During the last two seasons experimental work has been carried on in several States to test the effectiveness of calcium cyanide as a chinch-bug barrier. Where this material was applied in sufficient quantity around the margin of the field, or better, in the bottom of a furrow, it killed every chinch bug attempting to cross it, and as regards the actual result obtained by liberal use of the material it proved to be an ideal barrier. The cost of this method is usually from 10 to 15 times as great as is that of the barriers just mentioned. Calcium cyanide may be used with good effect in combination with creosote or coal-tar barriers by laying down narrow strips of calcium cyanide at right angles to these barriers. These strips should be about 8 inches long and 3 inches wide, and placed at intervals of 2 to 3 rods. (Fig. 5.) Calcium cyanide may also be used in the

bottoms of post holes, and will kill all bugs falling into the holes for several hours after it is placed in them.

BURNING ALONG THE BARRIER

It is possible to kill nearly all the chinch bugs along the barrier by flaming with a large blow torch. The type of torch used by plumbers is rather small for the most effective work. The best torches to use for this purpose are those made for melting or heating asphalt; they generate a very hot flame several inches in diameter and may be moved rapidly along the barrier line, enabling one to go down the side of the field at a slow walk, killing practically all the bugs massed against the barrier. This operation is expensive, the first cost of the torch being from $25 to $50, and the cost of operating from 50 cents to $1 per hour, including labor. Bugs may be killed by flaming the outer rows of corn, but in nearly every case the plants will also be killed.

FIG. 6.—A corn plant, showing how chinch bugs congregate on corn unless the plant is protected by a barrier

BARRIERS THAT ARE OF LITTLE OR NO VALUE

A number of chinch-bug barriers have been suggested which have proved to be nearly worthless. Barriers made by planting a narrow strip of some legume between the small grain and corn are of little value. Cowpeas or soy beans are the legumes most frequently used in this way. At the time of small grain harvest, these legumes are so small that the chinch bugs crawl through them, almost if not quite as readily as they would pass over the bare ground. To cite another instance, it has been suggested that the bugs would feed upon freshly cut cornstalks, laid in a continuous line along the margin of the small-grain field, and that this material as it sours would poison the bugs. Numerous tests with this type of barrier have shown that it is worthless. Occasionally considerable numbers of the cast-off skins of the bugs may be found scattered through the cornstalks, and might easily be mistaken for dead bugs. Close examination, however, has failed to show that any chinch bugs are killed by this kind of a barrier.

SPRAYING

As the chinch bug is a sucking insect, spraying will kill it only when a suitable spray comes in contact with its body. In most cases such sprays are rather expensive, and there is considerable difficulty in applying them in such a manner as to wet chinch bugs that are

clustered round the base of wheat plants or congregated on the first rows of corn. One of the best sprays for this purpose consists of one-half ounce of 40 per cent nicotine sulphate and 1 ounce of soap, all dissolved in 1 gallon of water. This spray kills all bugs with which it comes in contact, and is not injurious to the corn except when applied in such a manner that it accumulates in the heart or curl of the plant. Where this occurs the water generally evaporates and the soap sometimes kills the leaves, but in most cases no injury to the plant results from its use.

Certain grades of laundry soap, even when used alone, are fairly effective in killing the bugs, but have to be used with some caution, as they may injure the corn. Most soaps dissolve at the rate of 3 or 3½ ounces to a gallon of water, and used as a spray will kill all chinch bugs thoroughly wet with the solution.

Spraying, at best, is an expensive method of controlling the chinch bug, and should be resorted to only when the bugs have congregated on the first rows of corn (fig. 6), or along the barrier lines around the small-grain fields. Numerous attempts have been made to spray the bugs in the fields of small grain, but, though it has been found possible to kill practically all of the insects in this way, the expense of the operation has amounted to from $30 to $50 per acre, thus making the method impractical.

DUSTING

Chinch bugs which are congregated on the first rows of corn can sometimes be more effectively killed by dusting than by spraying. Less labor is required for dusting with insecticides, and although the expense of the material is greater than in the case of spraying, dusting can often be used to better advantage. A few of the bugs on the outer leaves of the plant may escape the dust, but nearly all can be killed. A 2 per cent nicotine dust is harmless to corn plants and very effective in killing chinch bugs, and may be applied at a fairly rapid rate. This dust may perhaps better be bought ready mixed, especially if the quantity needed be small, or it may be prepared by the user. By mixing 47½ pounds of hydrated lime with 2½ pounds of 40 per cent nicotine sulphate a 2 per cent nicotine dust is obtained. The mixing must be very thoroughly done, and the product kept tightly covered until used. Dust so prepared is usually cheaper than the ready-mixed material.

In experiments with calcium cyanide dust this material, when applied at the rate of 40 to 60 pounds per acre of small grain, killed nearly all of the chinch bugs in the field. This method is too expensive, however, to be practical. Calcium cyanide in dust form may be used for killing the bugs on the outer rows of corn, but it is usually impossible to prevent it from killing the plants. Spraying and dusting can be recommended only as emergency measures when the chinch bugs have escaped from the small grain and have become numerous on the corn before a barrier has been constructed.

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May 29, 1926

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